VEHICLE SEAT

TECHNICAL FIELD

[0001] This invention relates to a vehicle seat having a lower seat portion and a back portion formed by quick-plastic forming, superplastic forming or sheet hydroforming.

BACKGROUND OF THE INVENTION

[0002] Vehicle seat designs typically include a seatback frame and a lower seat frame. Typically, the seatback frame and the lower seat frame are formed from a multitude of components, such as metal tubing interconnected with springs, to provide necessary rigidity and contoured support structure to the frame. Each of the tubular components and spring components must be separately formed. Additionally, the components must be assembled and joined to provide the completed frame. The large number of frame components adds complexity, weight and cost to the finished seat.

SUMMARY OF THE INVENTION

[0003] A vehicle seat includes a lower seat portion and a back portion. The lower seat portion and the back portion are formed from at least one panel by a method selected from the group consisting of quick plastic forming, superplastic forming and sheet hydroforming. The lower seat portion and the back portion are cooperatively configured to form a seat frame.

[0004] Preferably, quick plastic forming is used to form the seatback portion and the lower seat portion. By utilizing quick plastic forming, complex, contoured shaping desirable for required component strength and rigidity as well as comfort considerations may be achieved with a unitary, one-piece panel, avoiding the use of a multitude of components to form the seatback portion and the lower seat portion.

[0005] In one embodiment of the invention, the lower seat portion and the back portion are formed from a unitary, one-piece panel. In another embodiment, the lower seat portion is formed from a first unitary, one-piece panel and the back portion is formed from a second unitary, one-piece panel. The lower seat portion may have a lower seat bottom panel portion and a matable lower seat top panel portion. The back portion may have a back bottom panel portion and a matable back top panel portion. The lower seat bottom panel portion and the lower seat top panel portion may be formed from a first unitary, one-piece panel and the back bottom panel portion and the back top panel portion may be formed from a second unitary, one-piece panel.

[0006] In another embodiment of the invention, the lower seat bottom panel portion and the back bottom panel portion are formed from a first unitary, one-piece panel and the lower seat top panel portion and the back top panel portion are formed from a second unitary, one-piece panel.

[0007] In yet another embodiment, the lower seat bottom panel portion and the lower seat top panel portion are formed from a first unitary, one-piece panel and the back bottom panel portion and the back top panel portion are formed from a second unitary, one-piece panel.

[0008] In still another embodiment, the lower seat bottom panel portion, the lower seat top panel portion, the back bottom panel portion and the back top panel portion are formed from a unitary, one-piece panel. The one-piece panel is characterized by a first bend. The lower seat top panel portion is on the first side of the first bend and the back top panel portion is on the second side of the first bend. The one-piece panel is further characterized by a second bend. The lower seat bottom panel portion is on a first side of the second bend and the lower seat top panel portion is on the second side of the second bend. The one-piece panel is further characterized by a third bend. The back top panel portion is on the first side of the third bend and the back bottom panel portion is on the side of the third bend.

[0009] The seat frame may be mountable with respect to a vehicle such that the seat frame is rigidly attached with respect to the vehicle. Alternatively, the seat frame may be matable with a seat track member. The seat track member may be mountable with respect to a vehicle and the seat frame may be movable along the seat track member relative to the vehicle. The lower seat portion and the back portion may be operably connectable to a pivot linkage such that the back portion is pivotable relative to the lower seat portion. In one aspect of the invention, the lower seat portion, the back portion, or both, may be adapted to receive a seat cushion.

[0010] A method of manufacturing a vehicle seat is provided. The method includes forming a unitary one-piece panel by a method selected from the group consisting of quick plastic forming, superplastic forming and sheet hydroforming, wherein the panel has a first portion formed as a lower seat portion and a second portion formed as a back portion. The lower seat portion has a lower seat bottom panel portion and a lower seat top panel portion. The back portion has a back bottom panel portion and a back top panel portion. The method may further include bending the panel between the first portion and the second portion. The method further includes bending the panel between the lower seat bottom panel portion and the lower seat top panel portion. The method may further include bending the panel between the back bottom panel portion and the back top panel portion. The method may further include joining the first portion and the second portion to one another to form a seat frame.

[0011] The above features and advantages, and other features and advantages of the present invention are readily apparent from the following detailed description of the best modes for carrying out the invention when taken in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIGURE 1 is a perspective schematic view of a unitary, one-piece panel having a lower seat portion and a back portion in a progressive first configuration;

[0013] FIGURE 2 is a perspective schematic view of the panel in Figure 1 in a progressive intermediate configuration in which the panel is partially bent;

[0014] FIGURE 3 is a perspective schematic view of a first embodiment of a vehicle seat formed from the panel of Figures 1 and 2 in a progressive final configuration;

[0015] FIGURE 4 is a perspective schematic view of the seat of Figure 3 mated with a seat track member on a vehicle and having cushions attached thereto;

[0016] FIGURE 5A is a perspective schematic view of a unitary, one-piece back portion for use in a second embodiment of a vehicle seat;

[0017] FIGURE 5B is a perspective schematic view of a unitary, one-piece lower seat portion for use in the second embodiment;

[0018] FIGURE 6A is a schematic plan view of a first unitary, one-piece panel having a back top panel portion and a lower seat top panel portion for use in a third embodiment of a vehicle seat;

[0019] FIGURE 6B is a schematic plan view of a second unitary, one-piece panel having a back portion panel portion and a lower seat bottom panel portion for use in the third embodiment;

[0020] FIGURE 7A is a schematic plan view of a first unitary, one-piece panel having a lower seat bottom panel portion and a matable lower seat top panel portion for use in a fourth embodiment of a vehicle seat;

[0021] FIGURE 7B is a schematic plan view of a second unitary, one-piece panel having a back bottom panel portion and a matable top back panel portion for use in the fourth embodiment;

[0022] FIGURE 8A is a perspective schematic view of a back top panel portion for use in a fifth embodiment of a vehicle seat;

[0023] FIGURE 8B is a perspective schematic view of a back bottom panel portion for use in the fifth embodiment;

[0024] FIGURE 8C is a perspective schematic view of a lower seat top panel portion for use in the fifth embodiment;

[0025] FIGURE 8D is a perspective schematic view of a lower seat bottom panel portion for use in the fifth embodiment;

[0026] FIGURE 8E is a fragmentary perspective schematic view of the mated panel portion of Figures 8A-8D operatively connected to a pivot linkage; and

[0027] FIGURE 9 is a flow chart diagram illustrating a method of manufacturing a vehicle seat.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Referring to the drawings, wherein like reference numbers refer to like components, Figure 1 shows a unitary, one-piece seat frame panel 10. Seat frame panel 10 includes a lower seat portion 14 and a back portion 18. The lower seat portion 14 includes a lower seat top panel portion 22 and a lower seat bottom panel portion 26. The back portion 18 includes a back top panel portion 30 and a back bottom panel portion 34.

[0029] A first bend line 36, a second bend line 38 and a third bend line 40 are shown on the seat frame panel 10. The first bend line 36 (shown in phantom) is disposed between the back top panel portion 30 and the lower seat top panel portion 22 such that the back top panel portion 30 is on a first side of the first bend line 42 and the lower seat top panel portion 22 is on a second side of the first bend line 44. The second bend line 38 is disposed between the lower seat bottom panel portion 26 and the lower seat top panel portion 22 such that the lower seat bottom panel portion 26 is on a first side of the second bend line 46 and the lower seat top panel portion 22 is on a second side of the second bend line 48. The third bend line 40 (shown in phantom) is disposed between the back bottom panel portion 34 and the lower seat bottom panel portion 26 such that the back bottom panel portion 34 is on a first side of the third bend

line 50 and the lower seat bottom panel portion 26 is on a second side of a third bend line 52.

[0030] A multitude of attachment receiving openings 54 are cut into the seat frame panel 10. Mounting openings 56 are disposed in the lower seat top and bottom panel portions 22, 26, respectively. Vent openings 58 are also cut in the seat frame panel 10. Preferably, the attachment receiving openings 54, the mounting openings 56 and the vent openings 58 are cut into the seat frame panel 10 after forming of the panel 10. A seat recession 62 is formed in the lower seat top panel portion 22 to enhance user comfort.

[0031] The one-piece panel 10 is formed with optional integral headrest portions 64. Additionally, the lower seat bottom panel portion 26 and the back bottom panel portion 34 are formed with integral corrugations 66 for strengthening such panels. The seat frame panel 10 is also formed with a multitude of optional, integral flanges 68. The integral flanges 68 include a first, second, third, fourth, fifth and sixth flange 70, 72, 74, 76, 78, and 80, respectively. The first and second flanges 70, 72 are disposed on the back bottom panel portion 34. The third flange 74 is disposed on the lower seat bottom panel portion 26. The fourth flange 76 is disposed on the lower seat top panel portion 22. The fifth and sixth flanges 78, 80, respectively, are disposed on the back top panel portion 30.

[0032] Quick plastic forming, superplastic forming or sheet hydroforming are employed to form the contours of the lower seat portion 14 and the back portion 18 (such as the seat recess 62 and the corrugations 66) from an originally flat panel (not shown) to obtain a more complex shape than is generally achievable with stamping. As used herein, a "panel" means a sheet of metal or plastic material, and may be referred to as such. Holes, apertures and openings are cut, punched, etc., after the contours are formed.

[0033] Superplastic forming (SPF) is described in U.S. Patent No. 5,974,847, issued November 2, 1999 to Saunders, et al, which is hereby incorporated by reference

in its entirety. When certain alloy compositions of steel or aluminum are suitably processed (such as with a very fine grain microstructure), they exhibit superplastic behavior at certain elevated temperatures. When deformed at these temperatures, the ductility (or elongation before yield or failure) of these materials exceeds several hundred percent. Such high levels of ductility can enable fabrication of very complex structures in a single sheet of material. A panel 10 of the design discussed above can be fabricated in one piece using such techniques.

[0034] In addition to various steels and aluminum alloys, other structural materials such as zinc, brass, magnesium, titanium and their alloys have also been reported to exhibit superplastic behavior. Furthermore, certain polymers and reinforced polymer composites have the required ductility to make this panel 10. These materials and other metal matrix composites could also be used to make the panel 10 of this invention, if desired.

[0035] In an example of superplastic forming, a blank, i.e., a sheet, is tightly clamped at its edges between complementary surfaces of opposing die members. At least one of the die members has a cavity with a forming surface opposite one face of the sheet. The other die opposite the other face of the sheet forms a pressure chamber with the sheet as one wall to contain the working gas for the forming step. The dies and the sheet are heated to a suitable SPF condition for the alloy. For SPF aluminum alloys, this temperature is typically in the range of 400° C. to 550°C. Electric resistance heating elements are located in press platens or sometimes embedded in ceramic or metal pressure plates located between the die members and the platens. A suitable pressurized gas such as argon is gradually introduced into the die chamber on one side of the sheet, and the hot, relatively ductile sheet is stretched at a suitable rate until it is permanently reshaped against the forming surface of the opposite die. The rate of pressurization is controlled so the strain rates induced in the sheet being deformed are consistent with the required elongation for part forming. Suitable strain rates are

usually 0.0001 to 0.01 s^{-1}. During the deformation of the sheet, gas is vented from the forming die chamber.

[0036] The '847 patent provides a method of stretch forming a ductile metal sheet into a complex shape involving significant deformation without excessive thinning of the sheet material and without tearing it. The method is particularly applicable to the stretch forming of superplastic alloys heated to a superplastic forming temperature. In the method, additional material from the initially flat sheet blank is pulled or drawn into the forming cavity for stretch forming. The additional material significantly reduces thinning and tearing in the formed part.

[0037] The method contributes to thickness uniformity in an SPF stretch-formed component by utilizing controlled draw-in of sheet metal to the forming chamber prior to application of gas pressure. In an illustrative practice, a preform, similar to a stationary male punch, is placed on the forming press platen opposite the die cavity. An aluminum blank, for example, is placed over the insert and heated to a suitable SPF temperature for the alloy. The die is then moved toward its closed position against the platen. In its closing motion, the die engages the edges of the aluminum sheet. The heated metal is pulled over and around the insert, and draw-in of blank material thus occurs. This results in a greater amount of metal in the die cavity prior to SPF blow forming. The quantity of additional metal can be managed by design of the size, shape and location of the preform on the platen or complementary die member. But the additional metal in the die cavity reduces the amount of strain required and, hence, the amount of thinning to form a desired geometry compared to conventional SPF.

[0038] Thus, by the judicious use of a suitable space-occupying metal preform on a die or platen member opposite the forming die, additional metal is easily drawn into the cavity during die closure without significantly increasing the complexity of the tooling. Care is taken in the design of the preform to avoid excessive wrinkling of the drawn-in metal and to maintain a tight gas seal at the periphery of the sheet upon full die closure. The uniformity in thickness of the stretch-formed part is improved. Mass

of the formed part can be reduced because the designer does not need to resort to thicker blanks to assure part quality. And, except for the simple preform, there is no increase in the complexity of the SPF tooling.

[0039] Quick plastic forming (QPF) is described in U.S. Patent No. 6,253,588, issued July 3, 2001 to Rashid, et al, which is hereby incorporated by reference in its entirety. For quick plastic forming, a preferred alloy is Aluminum Alloy 5083 having a typical composition, by weight, of about 4% to 5% magnesium, 0.3 to 1% manganese, a maximum of 0.25% chromium, about 0.1% copper, up to about 0.3% iron, up to about 0.2% silicon, and the balance substantially all aluminum. Generally, the alloy is first hot and then cold rolled to a thickness from about one to about four millimeters.

[0040] In the AA5083 alloys, the microstructure is characterized by a principal phase of a solid solution of magnesium in aluminum with well-distributed, finely dispersed particles of intermetallic compounds containing the minor alloying constituents, such as Al_6Mn.

[0041] Using QPF, large AA5083-type aluminum-magnesium alloy sheet stock may be formed into a complex three-dimensional shape with high elongation regions, like an SPF-formed part, at much higher production rates than those achieved by SPF practices. The magnesium-containing, aluminum sheet is heated to a forming temperature in the range of about 400° C. to 510° C. (750° F. to 950° F.). The forming may often be conducted at a temperature of 460° C. or lower. The heated sheet is stretched against a forming tool and into conformance with the forming surface of the tool by air or gas pressure against the back surface of the sheet. The fluid pressure is preferably increased continuously or stepwise from 0 psi gage at initial pressurization to a final pressure of about 250 to 500 psi (gage pressure, i.e., above ambient pressure) or higher. During the first several seconds up to about, e.g., one minute of increasing pressure application, the sheet accommodates itself on the tool surface. After this initial period of pressurization to initiate stretching of the sheet, the pressure can then be increased at an even faster rate. Depending upon the size and

complexity of the panel to be formed, such forming can normally be completed in a period of about two to twelve minutes, considerably faster than realized in superplastic forming. Thus, by working a suitably fine grained, aluminum alloy sheet at significantly lower temperatures and continuously increased, higher gas pressures than typical SPF practices, significantly faster and more practical forming (at least for the automobile industry) times are achieved.

[0042] Referring to Figure 2, the one-piece seat frame panel 10 is shown in an intermediate configuration with the back top panel portion 30 bent with respect to the lower seat top panel portion 22 at the first bend line 36 such that the back top panel portion 30 is rotated clockwise with respect to the seat top panel portion 22. The back bottom panel portion 34 is bent with respect to the lower seat bottom panel portion 26 at the third bend line 40 such that the back bottom panel portion 34 is rotated clockwise with respect to the lower seat bottom panel portion 26.

[0043] Referring to Figure 3, the one-piece seat frame panel 10 of Figures 1 and 2 is shown further bent between the lower seat top panel portion 22 and the lower seat bottom panel portion 26 at the second bend line 38 such that the lower seat top panel portion 22 is mated with the lower seat bottom panel portion 26 and the back top panel portion 30 is mated with the back bottom panel portion 34 to form a seat frame 82. When formed, the first flange 70 is mated with the sixth flange 80, the second flange 72 is mated with the fifth flange 78 and the third flange 74 is mated with the fourth flange 76. The mated flanges may be welded, bonded, hemmed or otherwise connected to one another to secure the lower seat top panel portion 22 to the lower seat bottom panel portion 26 and the back top panel portion 30 to the back bottom panel portion 34. Alternatively, if the one-piece seat frame panel 10 does not include the optional flanges 70,72,74,76,78,80, welding, bonding, hemming, fastening or other attachment means known to those skilled in the art may be used to fasten the lower seat top panel portion 22 to the lower seat bottom panel portion 26 and the back top panel portion 30 to the back bottom panel portion 34.

[0044] Referring to Figure 4, the one-piece panel 10 formed as the seat frame 82 has cushion portions 86 attached at the attachment receiving openings 54. The cushion portions 86 may be so attached with bolts, fasteners or, alternatively, snap-in components (not shown) attached to the cushion portions 86 and matable with the attachment receiving openings 56. The cushion portions 86 may be separate portions as shown or may together form a one-piece cushion. Seat track members 90 operatively connected to a vehicle 92 are shown having seat mounting portions 94 matable with mounting openings 56 in the seat frame 82. Those skilled in the art will recognize a variety of seat track members 90, seat mounting portions 94 and mechanisms for attaching such to a seat frame. Alternatively, the seat frame 82 may be rigidly attached to the vehicle 92 either directly or with a non-movable mount (not shown) disposed between the seat frame 82 and the vehicle 92. Those skilled in the art will recognize a variety of mechanisms for achieving rigid attachment between a seat frame 82 and a vehicle 92.

[0045] Referring to Figures 5A-5B, a lower seat portion 14A may be formed from a unitary, one-piece lower seat portion panel 96. A back portion 18A may be formed from a unitary, one-piece back portion panel 98. The seat portion panel 96 is formed with an integral seat attachment portion 100. Likewise, the back portion panel 98 is formed with an integral back attachment portion 102 that is matable with the seat attachment portion 100. Seat attachment portion 100 may be mated with the back attachment portion 102 by a variety of means including fastening, bonding, hemming and welding. When the seat attachment portion 100 and the back attachment portion 102 are mated (not shown), the seat portion panel 96 and back portion panel 98 form an alternative seat frame 82A.

[0046] Referring to Figures 6A-6B, a lower seat top panel portion 22B and a back top panel portion 30B are integrally formed from a unitary, one-piece top panel portion 104 (i.e., a first, unitary, one-piece panel). An integral lower seat bottom panel portion 26B and a back bottom panel portion 34B are integrally formed from a

unitary, one-piece bottom panel portion 106 (i.e., a second, unitary, one-piece panel). Referring to Figure 6A, a first bend line 36B (shown in phantom) is disposed between the lower seat top panel portion 22B and the back top panel portion 30B such that the lower seat top panel portion 22B is on a first side 42B of the first bend line 36B and the back top panel portion 30B is on a second side 44B of the first bend line 36B.

[0047] The one-piece top panel portion 104 and the one-piece bottom panel portion 106 include integral headrest attachment openings 108. The headrest attachment openings 108 may be formed in the top panel portion 104 and bottom panel portion 106 or, preferably, cut therein after forming. The headrest attachment openings 108 are configured to receive a headrest 110 shown in phantom.

[0048] Referring to Figure 6B, a second bend line 38B is disposed such that the lower seat bottom panel portion 26B is disposed on a first side of the second bend line 46B and the back bottom panel portion 34B is disposed on a second side of the second bend line 48B. The top panel portion 104 and the bottom panel portion 106 may be joined by connecting optional flanges (not shown) similar to those shown on the one-piece panel 10 of Figure 1. Alternatively, the top panel portion 104 may be joined to the bottom panel portion 106 by laser welding at a periphery 111 of the top panel portion and a periphery 112 of the bottom panel portion to form a seat frame 82B. Other attachment options known to those skilled in the art, such as adhesive bonding or fastening may also be used.

[0049] Referring to Figures 7A-7B, a unitary, one-piece seat portion panel 96C (i.e., a first, unitary, one-piece panel) and a unitary, one-piece back portion panel 98C (i.e., a second, unitary, one-piece panel) are illustrated. The seat portion panel 96C includes a lower seat top portion panel 22C and a lower seat bottom panel portion 26C separated by a first bend line 36C (shown in phantom) such that the top panel portion 22C is on a first side of the first bend line 42C and the bottom panel portion 26C is on a second side of the first bend line 44C. The seat portion panel 96C may be bent at the first bend line 36C by rotating bottom panel portion 26C in a clockwise downward

direction toward the top panel portion 22C to form a lower seat portion (not shown). Referring to Figure 7B, the back portion panel 98C includes a back top panel portion 30C and a back bottom panel portion 34C separated by a second bend line 38C (shown in phantom). The second bend line 38C is disposed between the back top panel portion 30C such that the back top panel portion 30C is on a first side of the second bend line 46C and the back bottom panel portion 34C is on a second side of the second bend line 48C. The back portion panel 98C may be bent at the second bend line 38C by rotating the back bottom panel portion 34C in a clockwise direction downward toward the back top panel portion 30C to form a back portion (not shown). The seat portion panel 96C may be mated or joined with the back portion panel 98C by any of the alternative joining methods discussed herein.

[0050] In Figures 8A-8E, another embodiment of a seat frame is depicted. Referring to Figure 8A, a unitary, one-piece back top panel portion 30D is illustrated. Referring to Figure 8B, a unitary, one-piece back bottom panel portion 34D is illustrated. The back top panel portion 30D and the back bottom panel portion 34D may be mated or joined with one another by any of the methods discussed herein. The back top panel portion 30D includes an integral back top panel portion flange 114. Similarly, the back bottom panel portion 34D includes an integral back bottom portion flange 116. Referring to Figure 8C, a unitary, one-piece lower seat top panel portion 22D is depicted. The lower seat top panel portion 22D is formed with a deep recession 118 as well as an integral top panel portion flange 120. The recession 118 and the top panel portion flange 120 are achievable through using the quick plastic forming, superplastic forming or sheet hydroforming processes.

[0051] Referring to Figure 8D, a unitary, one-piece lower seat bottom panel portion 26D is depicted. The lower seat bottom panel portion 26D includes an integral lower seat bottom panel portion flange 124. The lower seat top panel portion 22D and the lower seat bottom panel portion 26D may be mated or joined by any of the methods

discussed herein. When mated, the lower seat top panel portion flange 120 is also mated with the lower seat bottom panel portion flange 124.

[0052] Referring to Figure 8E, the mated lower seat top panel portion 22D and the lower seat bottom panel portion 26D form a lower seat portion 14D, including mated top panel portion flange 120 and lower seat bottom panel portion flange 124, forming a tube-like rod-receiving opening 128. The mated back top panel portion 30D and back bottom panel portion 34D form a back portion 18D including mated back top panel portion flange 114 and back bottom panel portion flange 116 which form a rod-receiving ring opening 130. A rod 134 (shown in phantom) is disposed through the rod receiving ring opening 130 and the rod-receiving opening 128. The rod 134 is operatively connected to a pivot linkage 138. Operation of the pivot linkage 138 allows the back portion 18D to pivot with respect to the lower seat portion 14D. Those skilled in the art will realize a variety of pivot linkage mechanisms operable to achieve such pivoting.

[0053] Referring to Figure 9, a method of assembling a seat 200 is shown in a flow chart. The method 200 includes forming a unitary, one-piece panel 204 by a method selected from the group consisting of quick plastic forming, superplastic forming and sheet hydroforming, the panel having a first portion having a lower seat bottom panel portion and a lower seat top panel portion and a second portion having a back bottom panel portion and a back top panel portion.

[0054] The method 200 may further include bending the panel between the first portion and the second portion 208. The method 200 may further include bending the panel between the lower seat bottom panel portion and the lower seat top panel portion 212. The method 200 may further include bending the panel between the back bottom panel portion and the back top panel portion 216. Bending 208, 212, 216 may be by press bending or other methods of bending known to those skilled in the art.

[0055] The method 200 may include joining the first portion and the second portion 216 to one another to form a seat frame. Joining 216 may be by welding,

hemming, fastening, bonding or other methods known to those skilled in the art. The method 200 may further include providing 220 the seat frame formed according to step 204. The method 200 need not be performed in the order shown in Figure 9.

[0056] While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternative designs and embodiments for practicing the invention within the scope of the appended claims.